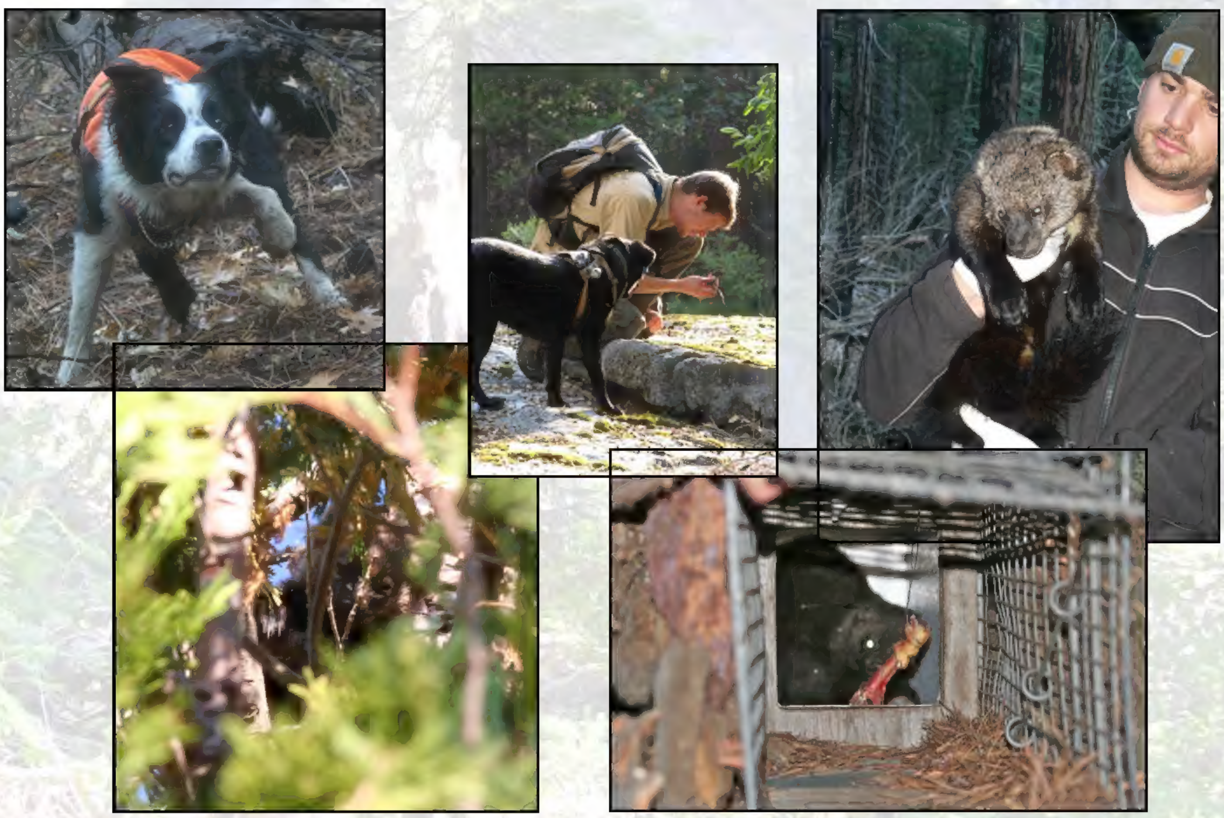
Kings River Fisher Project

Progress Report 2007-2010

USDA Forest Service

Pacific Southwest Research Station

Sierra Nevada Research Center



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EXECUTIVE SUMMARY

The Kings River Fisher Project was initiated in 2007 by the USDA Forest Service Region 5 and the Pacific Southwest Research Station for two reasons: 1) to fill gaps in our current understanding of fisher ecology and habitat requirements and 2) to address the uncertainty surrounding the effects of timber harvest and fuels treatments on select response variables of interest, including fishers and their habitat. Objectives include documenting demographic parameters, identifying the range of natural variation associated with these values, and relating this information to potential limiting factors such as disease, predation, and habitat.

To address these questions, the KRFP is using three overlapping monitoring techniques in a spatially nested design. Live-trapping provides data on population structure and individual health. Telemetry, both conventional VHF and GPS, provides data on animal movement and survival. Scat detector dog surveys provide additional information on population density, habitat use, and diet. Each method carries unique strengths and weaknesses, and overlapping them, both spatially and temporally, facilitates a more complete understanding of fisher ecology in the region and more precise estimates of demographic rates.

Since February 2007, 78 fishers have been captured and 72 of these have been radio-collared. These animals have been accurately relocated 3317 times, including both remote triangulations and walk-ins. 2284 scats have been collected, with genetic analysis completed on 1924. Thirty-two percent of these (N = 616) have been confirmed as fisher, with the remaining samples either failing to amplify or being identified as other species.

Using a combination of telemetry and scat dog data, we generated a preliminary density estimate of 13.4 fishers per 100 km^2. We observed reproductive activity for 79% of the adult females monitored during two breeding seasons, with 45 kits observed at 31 natal dens. We located an additional 64 maternal dens in a variety of structures. Survival rates ranged from 0.61 for subadult males to 1.0 for juvenile females, and predation accounted for 81% of all mortality. Genetically confirmed predators include mountain lion (40%), bobcat (40%), and coyote (20%).

We generated 95% kernel home range estimates of 1,113 ha for females and 4,522 ha for males. In agreement with most published literature, fishers were found in areas of higher canopy cover. However they were also found more often in areas with higher number of small (<20" dbh) trees, indicating that these trees may provide requisite structure and canopy. Fishers avoided edges, particularly with respect to resting sites, and were found on the lower portions of north facing slopes more often than any other topographic position. Fishers used a variety of tree species and structures for resting, with the most common choices being cavities in black oak and white fir. Diet was dominated by mammalian remains, though we documented a large diversity in food consumed including plants, birds, reptiles, and insects. All data presented here are

preliminary, and further work will identify the range of variability in these parameters as well as how they respond to forest management.

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I. INTRODUCTION

The Kings River Fisher Project (KFRP) was initiated in 2007 by the USDA Forest Service Region 5 and the Pacific Southwest Research Station for two reasons: 1) to fill gaps in our current understanding of fisher ecology and habitat requirements and 2) to address the uncertainty surrounding the effects of timber harvest and fuels treatments on select response variables of interest, including fishers and their habitat. Specific questions we are addressing include,

- What landscape elements dictate habitat selection and at what spatial scale?
- What are the responses of fishers to changes in forest structure and composition?
- Do changes in habitat quality translate into changes in fisher population vital rates by altering factors such as den site availability, exposure to predation risk, or physiological stress?
- How do fishers respond to changes that are a result of fuels treatments versus natural heterogeneity?

To fully investigate these questions, the current project will continue through 2014.

To answer these questions and maximize the information available, the KRFP is using three overlapping field monitoring techniques (live-trapping, radio telemetry, and detector dog surveys) in a spatially nested design. Live-trapping provides an opportunity to radio-collar animals as well as collect information on the age and sex structure of the population, reproductive activity, and disease history. Additional data collected at captures include bioelectrical impedance readings to evaluate animal health and body condition, and genetic samples to document maternal relationships as well as link telemetry and scat dog data. Telemetry provides survival, habitat use, and movement data. Scat dog surveys, a relatively new and non-invasive sampling method, provide information on habitat use and diet. More importantly, telemetry and scat dog surveys used in combination provide more robust estimates of population density, allow for checks on the number of untrapped animals, and may help identify behavior-specific habitat requirements such as differences in foraging and resting or denning habitat. Scats collected are genetically verified to species and typed to the individual level to link trapping, telemetry, and scat data.

Fifteen 1500 ha hexagons form the primary sampling units, and are hereafter referred to as the core study area. This is approximately the size of an average female fisher home range as reported by Mazzoni (2002). Fishers within this area are intensely monitored using telemetry and non-invasive techniques. The larger, or peripheral, study area includes all areas used by radio-collared fishers. Animals within the peripheral study but outside the core study area are subject to less intensive survival and reproduction-based monitoring. The boundary of the peripheral study area is dynamic, depending on the movements of collared animals, but covers approximately 53,200 ha.

II. STUDY OBJECTIVES

Currently, little is known about the Southern Sierra fisher population. Habitat preferences, reproductive rates, sources of mortality, and factors influencing dispersal are largely unknown. Our primary objective, identifying and filling gaps in our understanding of fisher ecology, emphasizes several critical factors:

A) *Population density* – Using a combination of telemetry monitoring and genetic mark/recapture analysis, we are estimating the number of animals, as well as the sex and age ratio, in the southern portion of the Sierra National Forest.

B) *Reproduction* – Using a combination of telemetry monitoring and remote video-monitoring, we are quantifying the natural range of variation in fisher reproductive activity including the percent of females reproducing each year, the number of kits produced, and den selection, and exploring how these factors are impacted by habitat and management actions

C) *Survival* – Predation on adult fishers is believed to be rare, but no information on sources or rates is currently available. By monitoring animals continuously, rapidly responding to mortality signals, and using a combination of field and laboratory forensic methods, we are documenting survival/mortality rates and as well as sources of mortality.

D) *Habitat use* – By combining multiple telemetry techniques with non-invasive survey methods, we are documenting behavior-specific habitat preferences such as foraging, denning, and resting habitat as well as travel corridors and hazardous areas. We are also investigating fishers' response to natural forest heterogeneity in order to better inform management decisions.

E) *Disease* – Fishers in the southern Sierra Nevada are separated from other populations by over 400km. As a result, they may be protected from diseases found in other fisher populations. Through a combination of live-trapping and laboratory analysis we are documenting exposure history and identifying what pathogens may pose significant risk.

Additional questions relating to timber harvest and fuels treatments that are being addressed include:

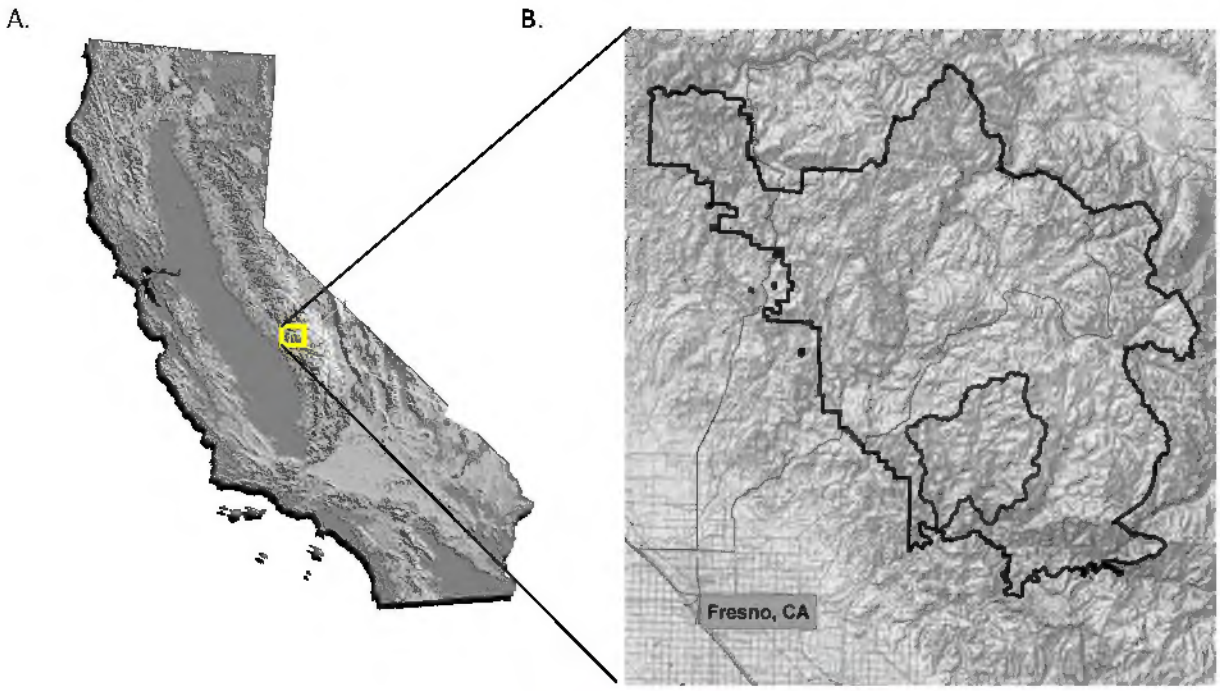
1) Is the use of treated areas by fishers reduced during and following treatments? If so, for how long?
2) Are there changes in the spatial arrangement of home ranges following treatments, theoretically in response to altered resources or predation risk?

3) Does implementation of fuel treatments result in decreased fisher body condition, as measured by relative fat content or hormone levels? If so, for how long?
4) Do fisher vital rates (such as density, survival, and fecundity) change following treatments? Is this related to the percent of home range treated?

III. STUDY AREA

The Kings River Project (KRP) is located west of Shaver Lake in the High Sierra Ranger District of the Sierra National Forest, between 1067 and 2134 meters (Figures 1 & 2). The site encompasses approximately 53,200 ha of Sierran mixed conifer, ponderosa pine, and montane hardwood-conifer habitat (Mayer and Laudenslayer 1988). Dominant tree species at the lower elevations include ponderosa pine (*Pinus ponderosa*), incense cedar (*Libocedrus decurrens*), and California black oak (*Quercus kellogi*). At higher elevations the vegetation is dominated by incense cedar, white fir (*Abies concolor*), and ponderosa pine. The climate is Mediterranean, with the majority of precipitation falling in winter months as rain and snow. Recreational activity, including camping, hunting, and off-road driving are common throughout the Sierra National Forest in the summer and fall months, and the area contains numerous logging roads and 4x4 routes. In winter, only main roads are plowed, numerous roads are gated, and recreational activity is reduced.

Figure 1. Dinkey Creek drainage in the Sierra National Forest, CA.



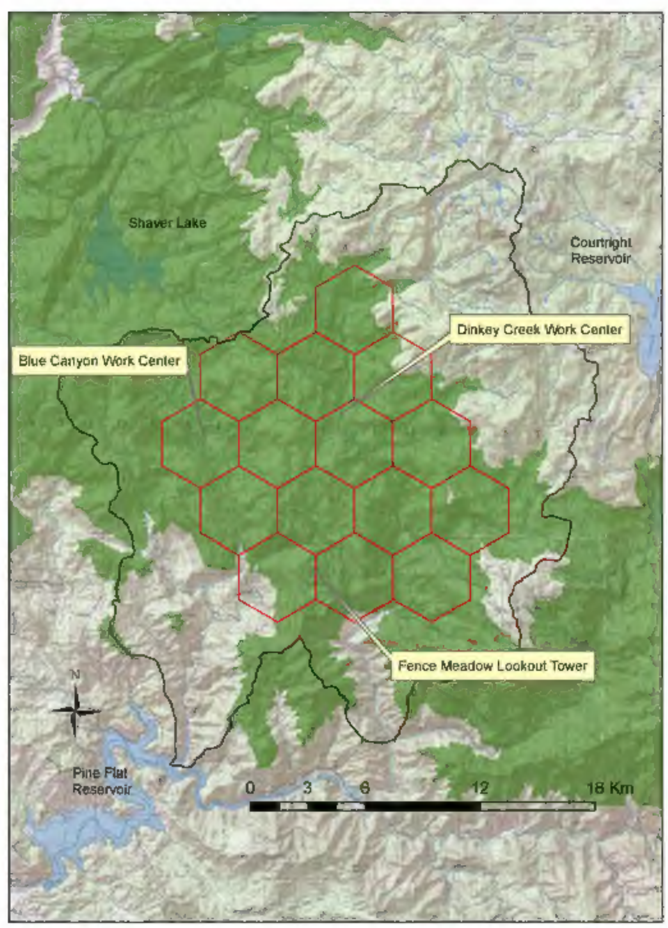


Figure 2. Kings River Fisher Project study area. (A) Map of California indicating the location of the Sierra National Forest (yellow box). (B) Location of the Kings River Project (KRP – smaller outline) within the Sierra National Forest (larger outline). (C) Core fisher study area within the KRP. Red hexagons identify core sampling units. Green indicates the elevational bounds used by fishers in this area.

IV. RESEARCH METHODS

Figure 3. Young male fisher captured on the Kings River Fisher Project in the Sierra National Forest. Electrical leads are connected to a bioelectrical impedance analyzer, which calculates body fat content based on mass, girth, and electrical impedance.

1. Survey methods

A. Trapping

Animals were captured using Tomahawk box traps equipped with an attached cubby for the animal's comfort and security. Traps were placed in alternating 1km² grid cells and were located in the most suitable habitat available within the target cell. Traps were covered with burlap, coroplast, or woody debris to both camouflage the trap and provide the animal additional security. Traps were checked every morning and closed when severe weather events were expected.

Figure 4. Male fisher, captured and collared on the Sierra National Forest, CA, being put back into a trap cubby to recover.

Captured fishers were transferred into a metal handling cone, and then anesthetized using a combination of Ketamine hydrochloride and Diazepam (200 mg Ketamine /1 mg Diazepam). Animals were weighed, sexed, and aged using a combination of tooth wear and sagital crest development. Body measurements taken included body length, tail length, girth, zygomatic arch width, footpad dimensions, and canine length. Biological samples collected included up to 6cc blood for epidemiological analysis, tissue and hair for genetic identification, and any ectoparasites observed. Bioelectrical impedance measurements were taken to non-invasively evaluate percent body fat (Figure 3). Animals were permanently marked using passive integrated transponder (PIT) tags inserted subcutaneously at the

nape of the neck and equipped with radio collars. Radio collars were equipped with leather spacers designed to stretch or break under pressure. Animals were placed back in the trap cubby, then released at the trap site when they were fully recovered (Figure 4

B Telemetry

A combination of auditory mortality checks, remote triangulations, aerial telemetry, and rest site walk ins was employed to monitor fisher survival, behavior, and habitat use. Conditions permitting, mortality checks on every animal were conducted every 2 3 days. Triangulations, consisting of 3 5 bearings at least 20° apart, were collected at least twice each week. Actual locations were triangulated using program Locate II (Pacer Computer Systems, Nova Scotia , and locations were screened for accuracy based on the time between bearings and estimated error polygons. Aerial telemetry support, provided by the University of California Sierra Nevada Adaptive Management Program, was used to keep track of dispersing or difficult to access animals. Walk ins were attempted whenever ground based bearings indicated that an animal was stationary. If the animal was successfully located in a resting structure, data on the structure and surrounding habitat were collected.

C Scat Detector Dog Surveys

Scat detector dog teams, provided by the University of Washington's (UW) Center for Conservation Biology and trained to locate fisher scat, conducted surveys of the core study area each fall and spring For the purpose of the detector dog surveys, the core study area was divided into fifteen 1500 ha hexagons Figures 2 . Each hexagon was surveyed three times each season by alternating teams Figure 5 . Surveys started at sunrise, lasted 4 5 hours, and began with a pre selected starting point and direction. Teams consisted of a dog and UW handler plus a PSW orienteer. The handler's responsibility was to carefully observe the dog's behavior, help the dog utilize air currents, and reward the dog when a sample was located. The orienteer's responsibility was to navigate for the team, and collect both samples and habitat

Figure 5. Scat detector dog teams from the University of Washington surveying for fisher scat in the Sierra National Forest, CA. Top Bud Marks and Marvin search along a downed log. Bottom Bud investigates a scat found by Frehly.

data. The orienteer kept the team within the hexagon boundary but the specific survey path was determined by the dog following air currents. Tracklogs were maintained and subsequent starting points were selected to ensure complete coverage of the hexagon. When a scat was located, it was collected and basic information on substrate, microhabitat, and canopy cover was collected. Scats were genetically confirmed as fisher at the University of Washington, then sent to the USDA Forest Service Rocky Mountain Research Station's Wildlife Genetics Lab for individual identification.

D. Reproduction

Adult and subadult female fishers were intensively monitored from March through July, 2008 through 2010, to document denning behavior. If a female fisher was found in the same structure for three subsequent days, it was assumed she had given birth. Intensive monitoring was continued for three weeks or until the female moved the kits to a new den. At that point, kits were assumed to be robust enough to avoid adverse impacts by researchers climbing the den tree and any associated extended absence by the mother. Dens were climbed immediately following the female's morning departure to minimize the chance of a researcher still being in the tree when she returned (Figure 6). The female's telemetry frequency was monitored continuously during climbing to provide warning if she returned. Once the cavity was located, a camera probe was used to count the number of kits. Kits were extracted from the den only when the cavity was easily accessible and they could be reached by hand. Extracted kits were sexed, weighed, measured, and PIT tagged. Once the females moved the kits from the den, the den was re-visited and re-climbed to provide data on the surrounding habitat and cavity dimensions. Dens were classified as either natal (where birth occurred), maternal (subsequent dens

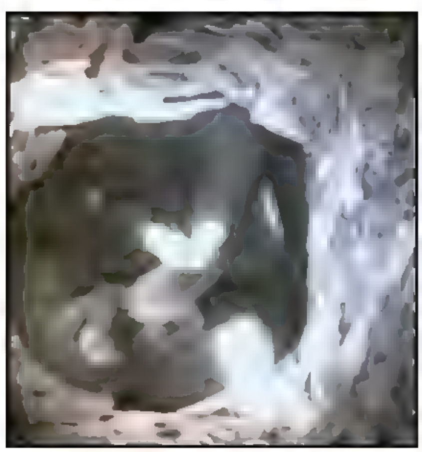


Figure 6. Methods for documenting fisher reproduction on the Kings River Fisher Project in the Sierra National Forest, CA. Top – accessing a den in a tall black oak. Bottom left – Two kits observed in a natal den. Bottom right – Female fisher and 2 kits caught leaving a summer den.

used by females with highly dependent kits), or summer resting sites used by females with dependant but highly mobile kits). Summer dens were considered more similar to rest sites than dens, and were excluded from den based analyses.

2. Analytical methods

A. Population density

We generated population density estimates using a novel approach that combined the scat detection results and telemetry monitoring (Thompson and Royle *in review*). Scat detector dogs have a much higher probability of detection than trapping or other non invasive monitoring techniques. At the same time, telemetry provides significantly greater spatial and movement data than any other monitoring method. To capitalize on these strengths, we modified a spatially explicit Bayesian mark recapture model designed for remote camera surveys (Royle and Young 2008). The modified, spatially explicit model estimated population density based on genetic mark recapture and used telemetry data to define home range centers and the effective trapping area.

B. Mortality and survival rates

Collars were equipped with mortality sensors on an 8 hour delay, and if a mortality signal was detected crews immediately attempted to recover the carcass. Most carcasses were collected within 2 days of death to minimize the confounding impact of scavengers. Detailed photos of the mortality site were taken, and both the area and carcass were searched for predator sign such as tracks and hair. Carcasses were collected and submitted to the University of California at Davis Veterinary Pathology Lab for necropsy. In addition, genetic analysis of saliva at bite wounds was used to corroborate field data for predator identification.

We estimated annual survival rates based on telemetry data using a combination of Kaplan Meier estimates and an age structured known fate analysis in Program MARK (White and Burnham 1999). Animals were defined as juveniles from birth to 1 April of the following year, at which point they graduated into subadults. They remained subadults for another year, becoming adults on 1 April of the second year following birth. Any animal that dropped its radio collar or was not heard for 1 month was censored until it was recollared and or relocated. Covariates examined included age, sex, and season.

C. Home range

Annual fixed kernel home ranges were generated using the Home Range extension for ArcGIS (ESRI, Redmond, CA). Ranges were generated only for animals with at least 25 telemetry locations within a given year. To avoid artificially inflating male territory size, we excluded male locations collected between March 1 and April 31 because breeding males make atypically large movements during that time. Analytical parameters

such as bandwidth and smoothing factors were independently selected for each animal to minimize range fragmentation Kie et al. 2010. For all animals, we used a 50% kernel estimate to identify core habitat. To estimate overall home range, we selected the combination of the smallest bandwidth and largest isopleth that minimized fragmentation and most closely matched the distribution of animal locations. Bandwith values used ranged from 50% to 100% of the reference bandwidth, and isopleths values selected ranged from 80% to 95%. This process was also informed based on knowledge of specific landscape features; in areas where topography created larger telemetry errors, smaller isopleths were chosen.

D. Habitat use

We evaluated fisher habitat use by comparing fisher locations and random points based on several landscape level databases available for the KRP. Primarily, we relied on fine scale, sub stand level vegetation data collected by the Sierra National Forest Parks and Rojas 2006. The authors subdivided stands into sub stand polygons based on aerial photo interpretation, with new boundaries being drawn around areas of homogenous forest. Across the KRP, this resulted in the identification of 13,125 sub stand polygons ranging from 5 to 336 acres each. Sub stand polygons were assigned vegetation characteristics based on 1,995 Common Stand Exam CSE vegetation plots conducted within the KRP. If one or more plots had been conducted within the sub stand polygon, the polygon was characterized according to those plots. If the sub stand polygon had no plots, data were assigned to that polygon using the Most Similar Neighbor MSN program Crookston et al. 2002. MSN relies on canonical correlation analysis to recognize relationships between remotely sensed and plot level data. In effect, an unsampled polygon was assigned the vegetation characteristics of the closest, "most similar", sampled polygon see Parks and Rojas 2006, for details.

Additional information was provided by the California Wildlife Habitat Relationships CWHR database, the 2008 Conservation Biology Institute CBI fisher habitat suitability model for the southern Sierra Nevada Spencer et al. 2008, and a topographic dataset developed by the UC Davis Information Center for the Environment ICE. The CWHR database characterizes forest structure based on the dominant tree size class 1 <2.5cm dbh, 2 2.5 15 cm dbh, 3 15 28 cm dbh, 4 28 61 cm dbh, 5 >61 cm dbh and percent canopy closure S 10 24%, P 25 39%, M 40 59%, D 60 100%. It also characterizes areas as high, medium, or low quality habitat for breeding and foraging based on expert opinion. The CBI habitat model, based on elevation, annual precipitation, and total above ground tree biomass, represents the most current and complete characterization of fisher habitat in the Sierra Nevada region.

Recent work has identified the need for improved management of the Sierra Nevada forests, particularly with respect to developing fuel reduction prescriptions that mimic historic fire and landscape conditions while accounting for topographic variation North et al. 2009. We evaluated the influence of topography on fisher

habitat selection by comparing fisher locations to a topographic dataset developed by the UC Davis ICE program (Underwood et al. 2010). The authors categorized the landscape based on a 3x3 matrix of slope position (ridge, mid slope, canyon) and aspect (north, neutral, south) (Figure 7). In order to identify small topographic depressions which maintain unique microclimates compared to the surrounding landscape, the authors defined ridges and canyons based on the difference between a cell's elevation and an average of the surrounding 50m. Aspect classes were developed to highlight varying thermal conditions across the landscape.

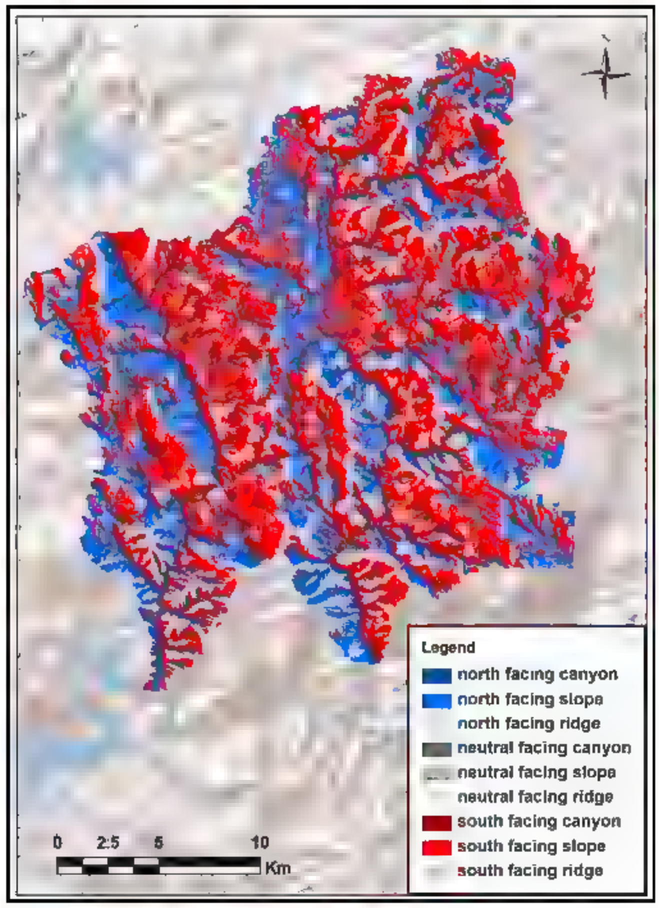


Figure 7. Map of the Kings River Project area in the Sierra National Forest, CA, reflecting slope position and aspect. Data developed at the UC Davis Information Center for the Environment.

We evaluated habitat at resting and denning sites by conducting a modified CSE plot centered on the rest or den structure. Each plot consists of five subplots, one centered on the structure and four additional plots located at cardinal compass directions around the central plot. Each subplot is circular and covers 1/4 acre. Outer subplots are located approximately 38.71 m from the central plot Each subplot contains a 1/100 ac plot for measuring seedlings and fuel loads, a 1/8 ac plot for measuring small trees and snags, and a 3/4 ac plot for large trees and snags. A variable prism plot was used to calculate basal area. From the rest or den structure, 20m tapes were extended in each cardinal direction. We measured shrub height at 1 m intervals along each tape. Wide-angle aerial photos, taken at breast height pointing up, were taken at the center and every 5 m along each tape to characterize canopy closure (Figure 8). Analysis of plot level vegetation data is ongoing

Figure 8. Example of a canopy closure photo taken at a fisher natal den in the Sierra National Forest, CA.

V. SUMMARY OF RESEARCH FINDINGS TO DATE

1. Survey Results

A. Trapping

As of 31 October, 2010, 78 fishers (36 male, 42 female) have been captured 139 times. Of these, 72 were radio collared. The remaining 6 included 3 kits (2 female, 1 male) that were extracted from dens and PIT tagged but never recaptured, 1 male juvenile deemed too small to collar and never recaptured, 1 subadult male collected as roadkill, and 1 adult female that died during handling (Table 1, Figures 9 & 10).

Table 1. Summary of fisher captures, by age and sex, on the Kings River Fisher Project in the Sierra National Forest, CA, 2007-2010.

Sex	Age at capture	# captured	Average weight (kg)
Male	Kit [1]	3	
	Juvenile	16	2.90
	Subadult	10	3.67
	Adult	7	3.76
Female	Kit [1]	2	
	Juvenile	13	1.92
	Subadult	11	2.09
	Adult	16	2.09

[1] Kit refers to juvenile animals removed from dens, tagged, and replaced. For analytical purposes, these animals are considered juveniles.

B. Telemetry

Between 23 June 2007 and 31 October 2010, we collected 3317 locations on 70 animals. The remaining two animals (72 collarings reported above, both adult males) disappeared immediately after capture. One was found dead several months later and the other was never relocated. The number of points per animal averaged 49 and ranged from 1 to 162 (SD = 45).

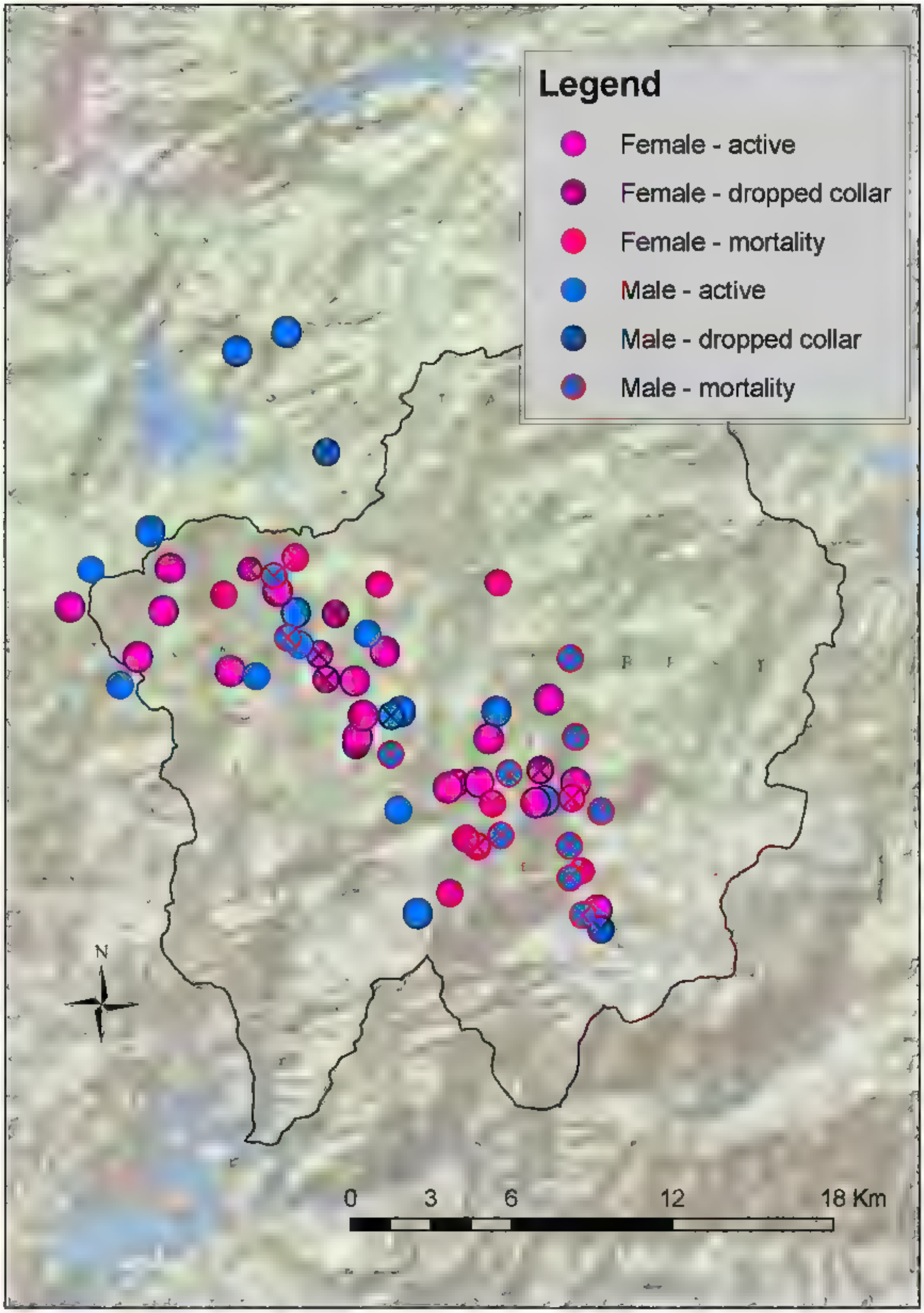


Figure 9. Approximate locations (home range centroids) of 72 fishers captured and monitored as part of the Kings River Fisher Project in the Sierra National Forest, CA, 2007-2010.

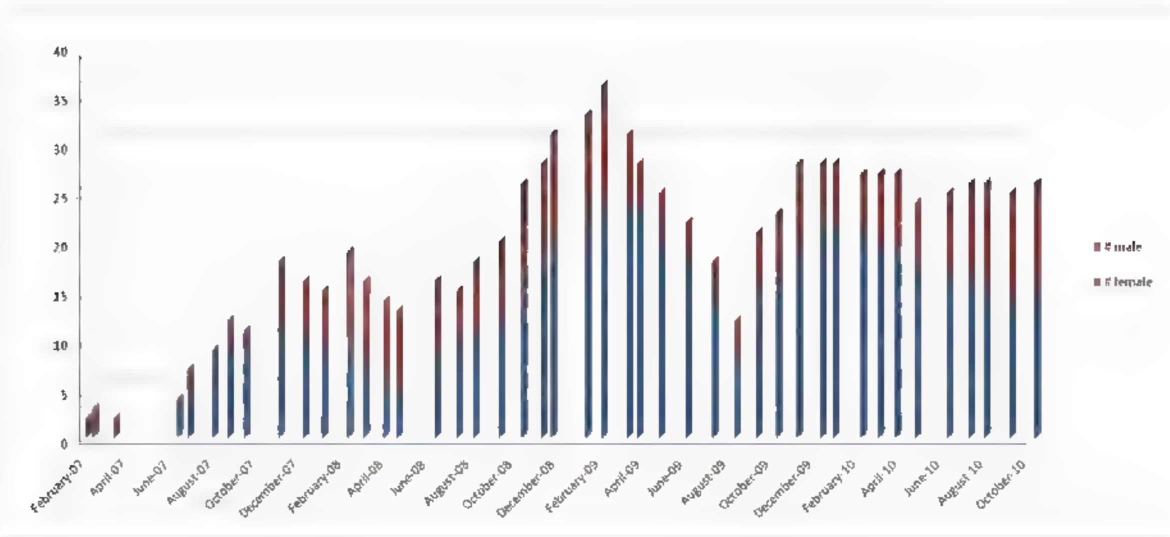


Figure 10. Number of animals being monitored by month as part of the Kings River Fisher Project in the Sierra National Forest, CA.

C. Detector Dog Surveys

As of 31 October 2010, eight scat surveys of the core study area were completed. An additional survey, part of a pilot study done in fall 200[illegible], covered portions of the core study area. Across all 9 surveys, 2284 samples were collected (Table 2). To date, 1942 samples have been tested for species id.

Of these 325 (20.8%) failed to amplify and 525 (27.1%) amplified unidentifiable DNA. Of the remaining 1092 samples, [illegible] were confirmed as fisher and the remaining 47[illegible] represented a variety of species (Figure 11). When amplification failures and mixed samples were excluded, a realistic estimate of detector dog accuracy is 58%. Two dog handler teams were used to conduct each survey and between 200[illegible] and 2009, 5 different detector dogs were used. Differences in their abilities represented a significant source of

Table 2. Summary of detector dog surveys on the Kings River Fisher Project, 200[illegible]–2009.

Survey	# scats collected	% fisher [1]
Fall 200[illegible]	315	45%
Spring 2007	242	57%
Fall 2007	381	[illegible]2%
Spring 2008	408	47%
Fall 2008	378	[illegible]2%
Spring 2009	218	80%
Fall 2009	342	-
Spring 2010	1[illegible]0[2]	-
Fall 2010	319	-
Total	***2284***	***58.8%***

[1] Percent of successfully amplified samples verified as fisher, excluding unknown samples

[2] Survey cut short due to detector dog being bitten by a rattlesnake

variation in survey accuracy. Individual accuracy ranged from 40% to 78%, and teams were alternated on each survey unit to help control for variability in dog accuracy.

Colleagues at the USFS Wildlife Genetics Laboratory in Missoula, MT are analyzing scat and tissue samples for individual identification of fishers using microsatellite DNA analysis. To date, 425 confirmed fisher scat samples and 40 tissue samples, taken from trapped and radio-collared fishers, have been analyzed. Amplification success was 100% and 9% for the tissue and scat samples respectively. Of the 40 scat samples individually genotyped, 28 were matched with known individuals and 12 were identified as representing 9 unknown animals.

Figure 11. Species identification results for scat detector dog surveys conducted on the Kings River Project of the Sierra National

2. Population Demographics

A. Density

Based on a combination of detector dog and telemetry data, we estimated 80.43 fisher home range centers within the sampling area plus an associated spatial buffer (Figure 12). Across the study area, this translates into a density estimate of 13.41 fishers per 100 km^2.. The associated 95% confidence interval ranged from 12.17 to 28.00 fishers per 100 km^2. This is a preliminary estimate based on a small dataset, as the project progresses we expect this estimate to become more precise. However it compares favorably with the estimates generated by M. Jordan (2007) of

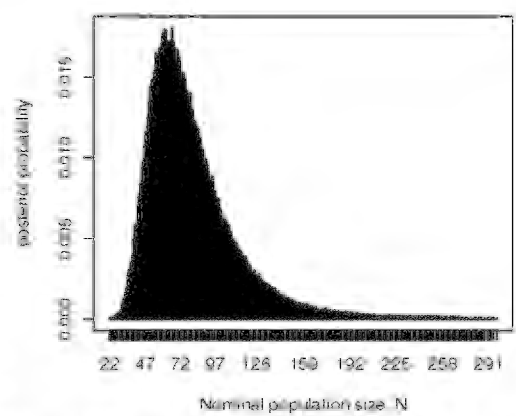


Figure 12. Posterior distribution of the number of fisher activity centers (i.e. "population size") within the Kings River Project Area of the Sierra National Forest, CA, based on a spatially explicit Bayesian mark-recapture model.

13.4 (95% CI: 7.[illegible] 24.2), 9.5 (95% CI: 5.[illegible] 1[illegible]7), and 10.0 fishers (9% CI: [illegible]7 14.4) [illegible] 100 km² during 2002, 2003, and 2004 respectively.

B Reproduction

In 2007, 7 of 10 adult females (70%) showed evidence of reproduction and nursing. Because trapping began in February 2007 and only one female was collared before the denning season, no estimates of litter size or den data are available for that year (Table 3).

In 2008, 10 of 11 adult females (91%) were documented to have produced litters. All known births occurred between 28 March and 10 April. Seven natal dens were located, and kits were successfully counted at 5. Litters averaged 1.[illegible] kits per litter (range: 1 2), with a total of 8 kits observed. Three more kits were documented via remote photographs of them accompanying collared females later in the season, though additional kits may have been missed. Two additional adult females captured after denning season showed evidence of nursing, but were never observed with kits.

Figure 13. Series of remote camera shots showing 2 fisher kits playing outside a summer den in the Sierra National Forest, CA, in June 2010.

Between 24 August 2008 and 1[illegible] January, 2009, 13 juvenile fishers were captured. Based on a combination of genetic and field evidence, 11 were subsequently assigned maternal relationships. The remaining 2 (1M:1F), captured in December and January, were either produced by uncollared females within the study area or had immigrated from outside the study area. Comparisons between field observations, trapping records, and genetic analysis indicated that three previously observed kits remained unaccounted for. Two were presumed to have died following death of the mother, F05. This female slipped her collar immediately following the identification of her natal den and the observation of 2 kits in the den. Despite a history of captures, a stable home range, and intensive trapping effort, neither she nor her two kits were ever recaptured. Of the 12 kits collared in 2008 ([illegible] male : [illegible] female), 3 males died, 1

male slipped his collar, 2 males are currently being monitored, 1 female died during her second year, 2 females dropped collars, and 3 females are currently being monitored.

In 2009, 12 of 16 adult females (75%) were documented to have produced litters. All 12 natal dens were located. Kits were successfully counted at 9 dens, and litters averaged 1.7 kits per litter (range 1-2) with a total of 15 kits observed. At 2 dens, 4 kits (1 male: 3 female) were successfully extracted, PIT tagged, and replaced. The remaining 3 litters were all observed via remote cameras, with 1 kit being photographed with each female. One additional female, captured on 8 July 2009, showed evidence of nursing but no kits were ever observed. During fall 2009 and winter 2010, we captured 7 juvenile fishers (4 male: 3 female). One, M23, was the male kit extracted from a den and PIT tagged earlier that spring. Genetic analysis to determine maternity for the remaining animals is pending.

In 2010, 13 of 16 adult females (81%) were documented to have produced litters. All 13 natal dens were located, along with 30 subsequent maternal dens. Kits were successfully counted at all dens with a total of 22 kits observed. Litter sizes ranged from 1 to 3 kits, averaging 1.7. Five juvenile fishers (2 male: 3 female) were captured in fall 2010. Genetic analysis to determine maternity for the remaining animals is pending.

Table 3. Summary of fisher reproduction observed on the Kings River Project Area of the Sierra National Forest, CA, 2007-2009

	2007	2008	2009	2010
Number of adult females monitored	10	11	16	16
Number of adult females producing kits	7	10	12	13
Total number of kits observed at dens	n/a	8	15	22

† Genetic confirmation of maternity pending

C. Survival Rates

Male survival was lower than female survival in all age classes, reflecting the age and sex structure typically seen during trapping efforts (Table 4, Figure 14). Survival was lowest for subadult males, and half of the adult male mortalities occurred in April or May following the animal's transition into the adult class. Our results therefore suggest that male mortality may be best defined as peaking during the 'young adult' period, late in the subadult year through

Table 4. Annual fisher survival rates, 2007-2010, on the Kings River Project Area of the Sierra National Forest, CA.

Age	Male	Female
Juvenile	0.64	1.00
Subadult	0.61	0.91
Adult	0.69	0.76

early in the first adult year. The probability of survival increased dramatically once a male reached the summer fall of its second year (Figure 13). The 100% survival rates for juvenile females (Table 4) reflect the fact that no collared animals of that class have died during the study to date.

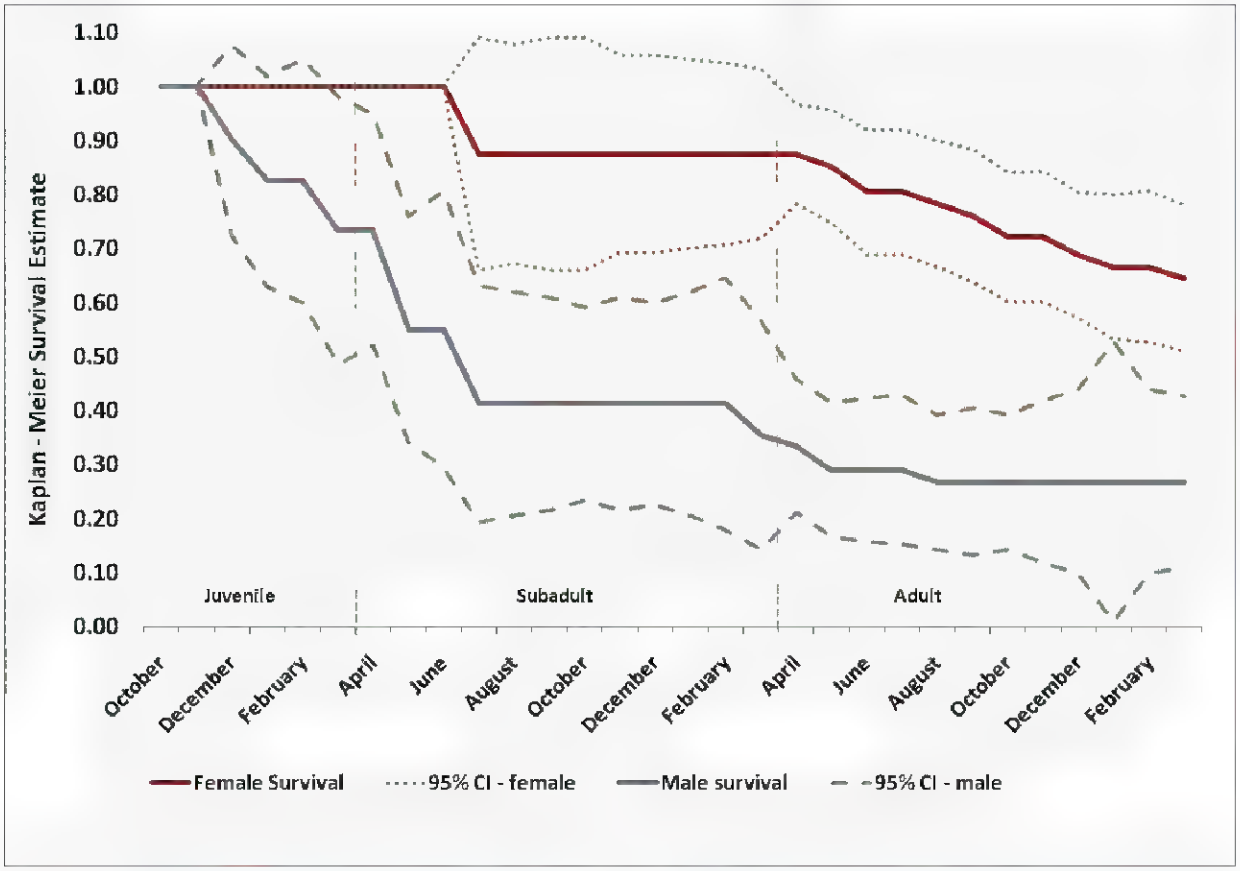


Figure 14. Kaplan Meier survival estimates for fishers in the Kings River area of the Sierra National Forest, CA. Values reflect the likelihood that a given animal will survive for a given length of time, beginning in the fall when juvenile animals are first caught. Animals transition into the next age class on April 1 until reaching adulthood.

D. Sources of Mortality

Twenty seven confirmed mortalities (14 male: 13 female) have occurred since the inception of the Kings River Fisher Project. Twenty two of these (81%) can be attributed to predation (16 confirmed, 6 suspected). While samples are still small, mountain lions and bobcats appear to be important predators of fishers, followed by coyotes (Table 5). Four mortalities have been confirmed via genetic analysis for mountain lion and bobcat and two for coyote. The 5 remaining mortalities were attributed to a variety of sources (Table 5). Mortality occurs year round, with a peak for males occurring in late winter early spring and most female mortalities occurring in the summer and fall. (Figures 15 & 16).

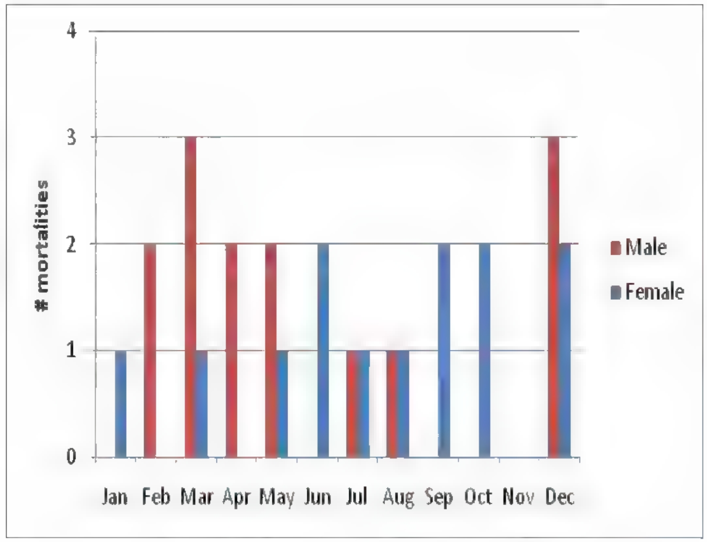


Figure 15. Summary of the number of fisher mortalities per month in the Sierra National Forest, CA.

Figure 16. Two fisher mortalities in the Sierra National Forest, CA. The animal on the left was killed by a bobcat, while the animal on the right was predated on by a mountain lion.

Table 5 Summary of fisher mortalities observed throughout the Kings River Fisher Project, 2007 2010..

Animal	Age at death	Date	Cause of death
Females			
F01	Adult	26 Dec 2007	Bobcat predation (DNA confirmed)
F02	Adult	3 Oct 2007	Coyote predation DNA confirmed)
F04	Adult	1 May 2009	Bobcat predation (DNA confirmed)
F06	Adult	22 March 2010	Unknown *
F07	Adult	23 Dec 2007	Lion predation DNA confirmed)
F08	Adult	8 Jun 2009	Bobcat predation (DNA confirmed)
F09	Adult	17 Jan 2010	Unknown
F14	Adult	19 Sept 2010	Unknown *
F17	Adult	19 June 2010	Unknown predation*
F18	Adult	18 Aug 2010	Unknown *
F32	Adult	7 Oct 2009	Unknown predation *
F34	Adult	12 Sept 2009	Died during handling **
F40	Subadult	29 July 2010	Unknown *
Males			
M01	Adult	1 May 2007	Bobcat predation (DNA confirmed)
M02	Adult	5 Mar 2007	Entombment
M04	Adult	5 Aug 2007	Unknown predation
M07	subadult	28 Feb 2008	Drowning
M08	Adult	14 Apr 2009	Unknown predation
M09	subadult	21 Mar 2009	Lion predation DNA confirmed)
M13	Adult	27 Feb 2008	Roadkill
M15	Juvenile	30 Mar 2009	Unknown predation (lion suspected) *
M16	Juvenile	7 Dec 2008	Lion predation DNA confirmed)
M17	Juvenile	28 Dec 2008	Lion predation DNA confirmed)
M21	Adult	6 Apr 2009	Coyote predation DNA confirmed)
M22	Juvenile	23 Dec 2009	Disease
M24	Subadult	26 Jul 2009	Unknown predation *
M27	Subadult	13 May 2010	Unknown predation *

* genetic confirmation of predator species pending
** emaciated and canine distemper positive

E. Disease

Sixty three blood and 68 scat samples from 47 known individual fishers have submitted for serological analysis. Preliminary results indicated the existence of canine distemper CVD), canine parvovirus CPV), canine adenovirus CAV), and toxoplasmosis in the fisher population, though only three animals have shown active infections (Table 6). One animal, M08, was actively infected with CPV when captured on 16 November 2007. The animal was captured again on 10 September 2008 and on 01 January 2010 and tested negative, indicating recovery. Another animal, M16, was negative for CPV when first captured on 1 October

2008. On 7 December 2008, he was killed by a mountain lion and post mortem analyses of the carcass indicated that he was actively infected with CPV.

On 12 September, 2009, a small female fisher was captured. Based on the animal's timid behavior and small size, it was assumed to be a juvenile. The animal was anesthetized using the dosage appropriate for juvenile animals. Upon removing the anesthetized animal from the handling cone, technicians realized that the animal was in fact an adult female in extremely poor condition – emaciated with lesions on the neck, inside of legs, and pads. Within minutes the animal stopped breathing and technicians attempted resuscitation using a combination of Doxopram and CPR. Post mortem analysis indicated the animal was actively infected with CDV, and mortality was attributed respiratory distress due to anesthesia compounded by the CDV infection. A report summarizing the mortality was submitted to CaDFG, and a subsequent review of capture and handling procedures recommended no changes to the current animal handling protocol.

Table 6. Results of epidemiology analyses of fisher blood and scat samples collected as part of the Kings River Fisher Project on the Sierra National Forest. Numbers in parentheses indicate the number of male and female samples, respectively.

	Exposure[1]		Active Infection[2]		Post-mortem samples[3]	
	# animals tested	# pos.	# animals tested	# pos.	# animals tested	# pos.
Canine Distemper (CDV)	51 (25, 26)	5 (2, 3)	47 (22, 25)	0	12 (6, 6)	4 (2, 2)
Canine Parvovirus (CPV)	51 (25, 26)	8 (5, 3)	47 (22, 25)	1 (1, 0)	12 (6, 6)	1 (1, 0)
Canine Adenovirus (CAV-2)	51 (25, 26)	3 (1, 2)	47 (22, 25)	0	12 (6, 6)	0
Canine Herpesvirus (CHV)	51 (25, 26)	2 (1, 1)	47 (22, 25)	0	12 (6, 6)	0
Toxoplasma gondii (Toxo)	51 (25, 26)	26 (12, 14)	47 (22, 25)	0	12 (6, 6)	6 (4, 2)

[1] "Exposure" summarizes the analysis of blood samples taken from live animals at capture, reflecting the number of animals carrying antibodies to each virus. These are animals that have been exposed to the virus but are not currently infected.

[2] "Active infection" summarizes the analysis of scat samples collected from live animals at capture, and reflects the number of animals actively shedding the virus.

[3] "Post mortem samples" indicates samples taken from animals that died from a variety of causes.

F. Home Range

From 2007 through 2010, 39 animals provided sufficient data to generate 60 annual home range estimates (46 females, 14 males) (Figure 17, Table 7). Adult female annual home ranges (n = 39) averaged 1,113 ha (SD = 653 ha), with core use areas averaging 275 ha (SD = 167 ha). Subadult female annual home ranges averaged 2 8 ha (SD = 195 ha). Adult male annual home ranges, excluding the large, extra territorial movements seen in March and April, averaged 4522 ha (SD = 1932ha), while subadult male home ranges averaged 2031 ha (SD = 1297 ha).

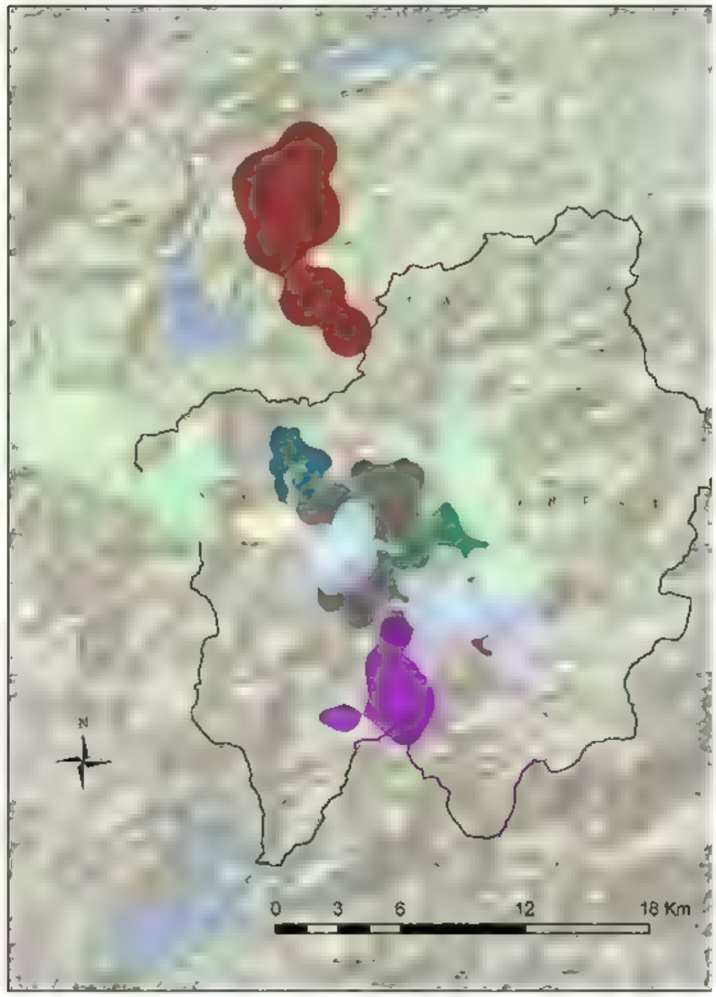


Figure 17. 2009 home ranges for male (dark colors) and female (light colors) fishers in the Kings River Area of the Sierra National Forest, CA.

Table 7. Annual home ranges (± SD), in hectares, for female and male fishers in the Kings River Area of the Sierra National Forest, CA, 2007 2010.

	Female			Male		
	N	50%	95%	N	50%	95%
2007	9	314 ± 122	1337 ± 623	1	1021	4141
2008	11	237 ± 186	1082 ± 577	3	508 ± 137	1820 ± 208
2009	15	297 ± 180	990 ± 727	6	466 ± 380	1875 ± 1265
2010	11	305 ± 187	1069 ± 599	4	929 ± 502	4385 ± 2202
Total	*46*	*279 ± 171*	*1096 ± 637*	*14*	*647 ± 414*	*2635 ± 1870*

5. Habitat Use

A. Overall habitat selection

Based on all locations, fishers were located in areas that were further from edges, had higher canopy closure, had more small trees (< 20") per acre, and more snags per acre than random locations (Table 8). The relationship with edge, canopy, and small tree density was universal among all location datasets. The association with snags was limited to telemetry locations. Telemetry locations were also negatively associated with the number of large snags and large trees (>35") per acre. While inconsistent with much of the published literature, this result is consistent with other findings in our study area. In the southern Sierra Nevada, logging and fire suppression have facilitated a change in stands dominated by large trees to stands that include fewer large trees and more small trees. Fishers are generally observed resting in the largest structures available (Purcell et al. 2009). Select logging practices used historically removed some large trees, releasing the remaining trees to grow larger while smaller trees filled in the gaps. In unlogged areas, age classes are more evenly distributed. The small trees where we find fishers appear to provide the requisite canopy cover as long as a suitable large structure is available. Further analysis is needed to clarify this relationship.

Overall, fishers showed strong preferences for canyon bottoms. We observed greater use of north facing canyon bottoms and of south and neutral facing canyon bottoms compared to availability, though selection was reduced for the latter two categories (Table 9). Fishers avoided using edges, though the strength of selection varied among datasets.

Figure 18. Examples of fisher habitat in the Kings River Area of the Sierra National Forest. Left – Conducting a detector dog survey through Sierra mixed conifer habitat. Right – Female fisher resting in a large, broken snag on a platform created by an intersecting, smaller snag.

Table 8. Topographic and forest characteristics associated with fisher locations in the Kings River Area of the Sierra National Forest, 2007 2010. Values reflect mean and standard deviations. Shaded values represent significant differences from random sites based on a 2 tailed T test, controlled for multiple comparisons. I'm surprised that some of these were significant based on the small differences in the means. Move this table above the previous table

Method: / Variable	Random (N = 1551)	All locations (N = 3328)	Telemetry (N = 2551)	Scat (N = 499)	Rest site (N = 278)
Distance to water	203.9 ± 154.3	196.4 ± 183.6	200.5 ± 183.9	160.2 ± 162.2	223.2 ± 206.7
Distance to edge	72.1 ± 88.2	89.9 ± 91.7[1]	88.1 ± 91.3[1]	89.8 ± 85.2[1]	106.2 ± 104.3[1]
% canopy closure	61.2 ± 22.7	68.4 ± 25.5[1]	68.4 ± 20.8[1]	68.2 ± 18.6[1]	68.6 ± 19.6[1]
Total basal area	181.5 ± 85.0	182.3 ± 81.1	188.7 ± 75.0	195.2 ± 72.6[1]	179.0 ± 83.1
Trees ac 0 10" dbh	432.6 ± 397.6	609.6 ± 508.1[1]	614.2 ± 517.4[1]	595.2 ± 485.1[1]	593.0 ± 460.9[1]
Trees ac 10 20" dbh	46.4 ± 38.1	51.6 ± 38.9[1]	51.0 ± 39.6[1]	52.9 ± 35.0[1]	55.0 ± 38.7[1]
Trees ac 20 30" dbh	14.7 ± 11.8	15.2 ± 11.0	15.1 ± 11.1	15.8 ± 10.8	15.8 ± 10.8
Trees ac 30 35" dbh	2.9 ± .2	2.7 ± 3.2	2.6 ± 3.2	2.9 ± 3.1	2.7 ± 2.8
Trees ac >35" dbh	3.9 ± 3.8	3.3 ± 3.3[1]	3.1 ± 3.2[1]	4.0 ± 3.5	3.5 ± 3.2
Snags ac 5 15"dbh	6.3 ± 13.5	8.5 ± 16.6[1]	8.6 ± 17.2[1]	8.4 ± 14.3	7.4 ± 14.5
Snags ac 15 24"dbh	1.8 ± 2.7	2.1 ± 2.6[1]	2.1 ± 2.7[1]	2.1 ± 2.4	2.0 ± 2.0
Snags ac 24 35" dbh	0.9 ± 1.4	1.0 ± 1.5[1]	1.0 ± 1.6[1]	1.0 ± 1.3	1.0 ± 1.4
Snags ac >35" dbh	0.6 ± 1.2	0.5 ± 1.1	0.5 ± 1.1[1]	0.7 ± 1.1	0.6 ± 1.2

[1] Value is significantly different than random based on a 2 tailed T test controlled for multiple comparisons.

Table 9. Habitat selection by fishers on the Kings River Area of the Sierra National Forest, CA, 2007 2010, by topographic position. Values are chi square statistics reflecting the difference between use and availability followed by the associated P value. Symbols indicate the type of selection: '+' selection, ' ' avoidance. Boldface type indicates statistically significant values, controlled for multiple comparisons. "Canyon" refers to the lower third of a slope, "slope" refers to mid slope position, and "ridge" refers to the upper third of a slope. "Neutral" refers to east or west facing aspects.

[illegible]	[illegible]	[illegible]	[illegible]
North facing canyon	**27.35 (*P < 0.0001*) +**	**144.4 (*P < 0.0001*) +**	**26.55 (*P < 0.0001*) +**
North facing slope	5.25 *P = 0.022*	**7.6 (*P = 0.006*) -**	0.09 *P = 0.761*
North facing ridge	0.37 *P = 0.544*) +	**0.37 (*P = 0.005*) -**	0.47 *P = 0.495*)
Neutral facing canyon	6.07 *P = 0.014*	**46.4 (*P < 0.0001*) +**	**6.90 (*P = 0.009*) +**
Neutral facing slope	1.84 *P = 0.175*)	2.9 *P = 0.086*)	0.09 *P = 0.760*)
Neutral facing ridge	**7.76 (*P = 0.005*) -**	6.1 *P = 0.014*)	2.12 *P = 0.145*)
South facing canyon	**35.54 (*P < 0.0001*) +**	**78.4 (*P < 0.0001*) +**	3.31 *P = 0.069*) +
South facing slope	4.29 *P = 0.038*)	**22.5 (*P < 0.0001*) -**	3.88 *P = 0.049*)
South facing ridge	**12.44 (*P = 0.0004*) -**	**48.3 (*P < 0.0001*) -**	5.74 *P = 0.017*)

B. *Resting habitat*

Between 2007 and 2010, we located 376 fisher resting sites. On 319 occasions, technicians were able to identify the structure the animal was resting in (Table 10. On the remaining 57 occasions, the signal was identified as coming from a specific area or group of trees however the animal fled before the exact structure could be identified. For resting sites located in trees or snags, cavities were used 58% of the time, followed by broken tops 16% and branch clusters 11%. Large limbs, stick nests, and mistletoe brooms *Phoradendron flavescens* were also infrequently used. Fishers were found resting in logs 17 times, in rockpiles 14 times, underground once, and in a snow cave once. For 268 of the 319 structures identified, data on dbh, tree height, and the height of the microsite used were later recorded. Figure 19, Table 11.

We located fishers resting lower on slopes more often than would be expected based on a random distribution, with significant selection being shown for north and neutral facing canyon bottoms (Table 9. Fishers rested in all other topographic positions less often than would be expected based on a random distribution, though selection was not statistically significant. Resting sites were also located further from

forest edges than both random locations and all other location datasets, indicating that fishers may use different criteria for selecting resting habitat than when foraging or travelling (Table 8).

Table 10. Summary of denning and resting structures used by fishers in the Kings River Area of the Sierra National Forest, CA, 2007-2010.

Species (condition)	Natal Dens	Maternal Dens	Resting
Black Oak (live)	12	32	78
Black Oak (snag)	2[1]	0	10
White Fir (live)	6	6	51
White Fir (snag)	4	8	63 (+ 3 logs)
Incense Cedar (live)	4	4	25
Incense Cedar (snag)	1	6[2] (+ 1 log)	12 (+ 9 logs)
Sugar Pine (live)	0	0	15
Sugar Pine (snag)	0	4	8 (+ 1 log)
Ponderosa Pine (live)	1	2	29
Ponderosa Pine (snag)	0	0	13 (+ 2 logs)
Total	***30***	***63***	***319***

[1] one of these structures was used twice by different females

[2] one structure used twice by the same female

Other species used as rest sites include alder (1), Giant Sequoia (1), hazel (1), Jeffery pine (5), red fir (1)

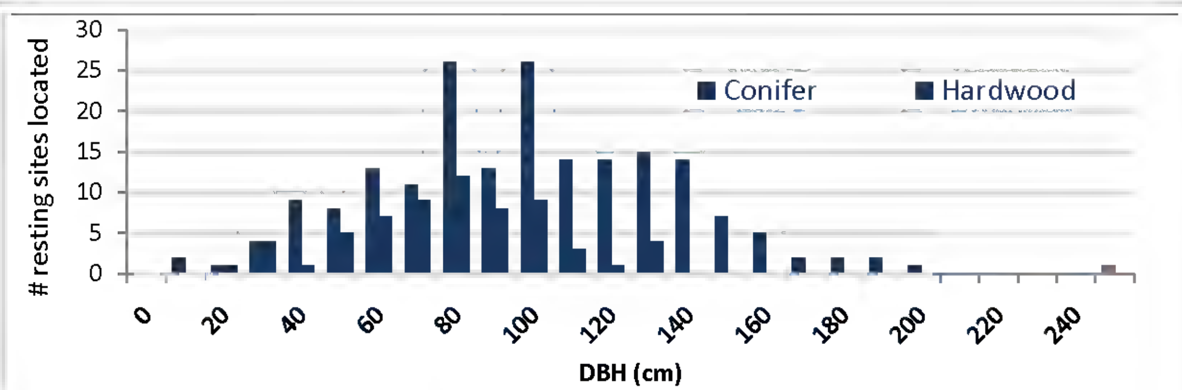


Figure 19. Distribution of tree size (dbh) for hardwood and conifer trees selected as resting sites by fishers in the Kings River Area of the Sierra National Forest, CA, 2007-2010. Conifer trees averaged 94.7 ± 38.5 cm, hardwood trees averaged 74.3 ± 25.5 cm.

Figure 20. Examples of structures used as resting sites by fishers in the Sierra National Forest, CA. Clockwise from top left – cedar log, cavity in the base of a black oak, deformity in a white fir, cedar snag, F26 looking out of a live cedar, mistletoe broom in a sugar pine.

Table 11. Summary of 268 resting structures located on the Kings River Fisher Project, 2007 2010, on the Sierra National Forest, CA.

Species / Structure		N	Average dbh (cm)	Average height (m)	Average microsite height (m)
White Fir	All	92	96.0	25.5	15.1
	Live	40	85.0	37.1	22.7
	Snag	52	104.5	16.6	9.3
Incense cedar	All	21	112.0	31.4	17.0
	Live	16	114.0	31.1	14.7
	Snag	5	105.4	32.5	24.5
Jeffery pine	All	5	110.2	19.0	12.8
	Live	2	105.0	19.8	17.5
	Snag	3	113.7	18.4	9.7
Black oak	All	64	74.3	16.2	6.8
	Live	56	72.8	17.2	7.3
	Snag	8	83.1	10.0	4.1
Ponderosa pine	All	36	82.7	35.4	17.8
	live	25	84.1	39.3	22.9
	snag	11	79.5	26.5	6.1
Sugar pine	All	17	106.8	37.2	15.1
	Live	12	105.0	42.2	18.0
	Snag	5	111.2	25.2	8.1

. *Denning habitat*

We located a total of 95 dens, 31 natal and 64 maternal, between 2007 and 2010 Figure 21 . Two dens, one natal and one maternal, were reused. One black oak snag was used as a natal den by a female in two years. An incense cedar snag was used as a maternal den by 2 different females in subsequent years.

Results to date indicate that natal dens were located preferentially at the bottom of north facing slopes and mid slope on south facing slopes. Maternal dens were located at the bottom of south facing slopes more often than expected, and few dens of any kind were found on ridges Figure 22 . Live black oaks were the

most commonly selected structure for denning, accounting for 40% of natal dens and 51% of maternal dens (Table 10). Live black oaks selected as natal dens were among the largest oaks used, with an average dbh of 8[illegible].9 cm as opposed to oak resting sites which averaged 72.8 cm dbh. On the other hand, oaks used as maternal dens were often smaller than those used as resting sites, averaging [illegible]0.0 cm dbh. Live conifers used as natal dens averaged 114.9 cm dbh, while those used as maternal dens averaged 9[illegible].3 cm dbh. Conifer snags used as natal dens averaged 99.5 cm dbh, while those used as maternal dens averaged 101.7cm dbh.

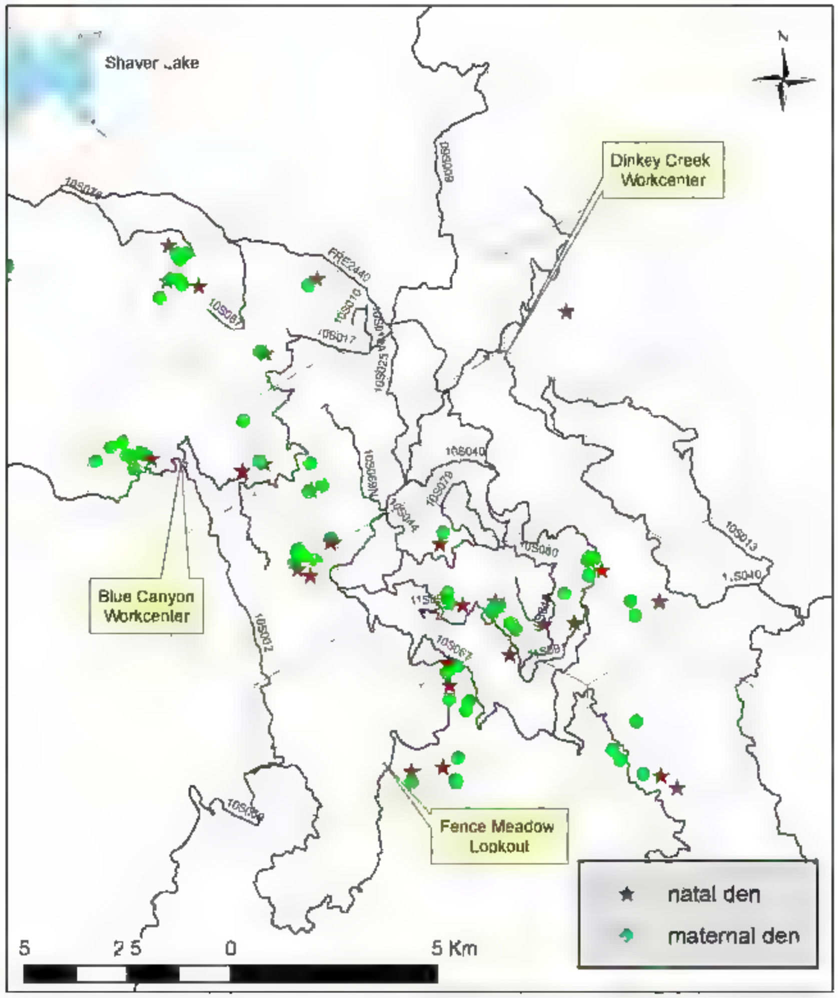


Figure 21. Distribution of fisher dens located in the Kings River Area of the Sierra National Forest, CA, 2007-2010.

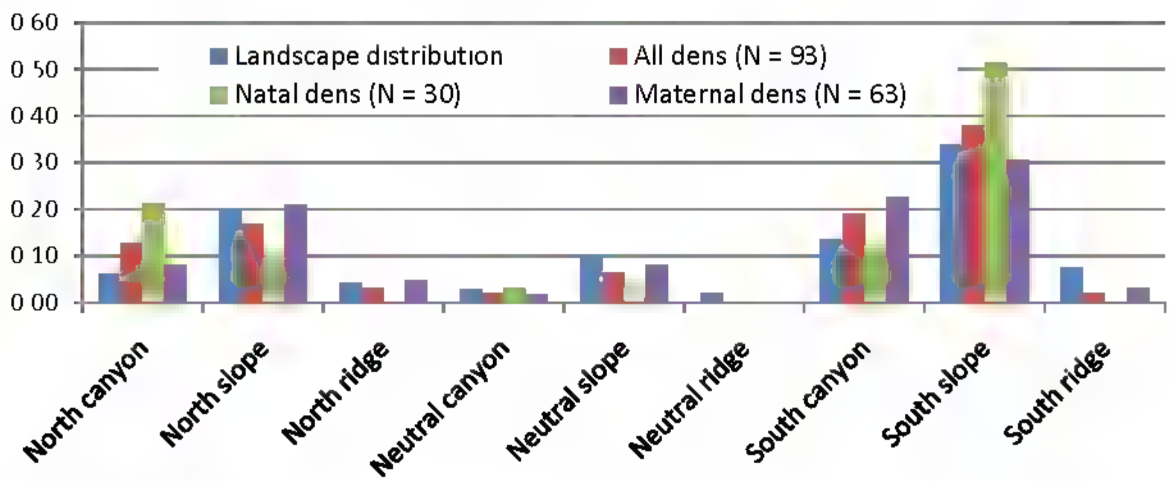


Figure 22. Distribution of fisher dens, with respect to slope position and aspect, in the Kings River Area of the Sierra National Forest, CA, 2007-2010.

Example: Natal den in live white fir

In 2009, F09 denned in a tall white fir near Fence Meadow. The den was located in a cavity near the top

Example: Natal den in black oak snag

This snag was used as a natal den by F05 in 2008 and again as a natal den by F13 in 2010. The entrance, a broken branch halfway up on the left side, was about 2m off the ground.

Figure 23. Examples of dens used by female fishers in the Kings River Area of the Sierra National Forest, CA.

Example – Maternal den in a live black oak

In 2010, F16 used a live black oak in the Big Creek drainage as a maternal den. The cavity entrance was through an old broken branch.

Example – Natal den in a live sugar pine

In 2008, F08 denned in a large sugar pine near the Fresno Flats campground. The den was located in a dead section of the pine approximately 15 m up.

6. Food Habits

Prey remains were dominated by mammalian remains, which were found in 95% of the 164 scats analyzed to date. Ten different mammalian species were identified (Table 12 . However the single most frequent prey item identified was alligator lizards in 11.6% of scats , followed by yellow jackets in 6.1% of scats .

Table12. Prey items identified from scats collected during detector dog surveys, 2006 2010.

Class	Order	Family	Genus	Species	Common Name	# occur.	% occur.
Planta		Ericaceae	Arctostaphylos		Manzanita sp	7	4 27%
		Rosaceae	Prunus	emarginata	W chokecherry	1	0 61%
					Subtotal	***8***	**4.88%**
Aves					unknown	44	26 83%
	Passeriformes					3	1 83%
	Piciformes	Picidae	Colaptes	auratus	Northern flicker	3	1 83%
					Subtotal	***50***	**30.49%**
Mammalia					unknown	115	70 12%
	Artyodactyla	Cervidae	Odocoilius	hemionus	Mule deer	1	0 61%
	Rodentia				unknown	3	1 83%
		Muridae	Arborimus	longicaudus	Red tree vole	1	0 61%
			Clethrionomys	californicus	CA red backed vole	2	1 22%
			Phenacomys	intermedius	Heather vole	1	0 61%
		Cricetidae	Peromyscus	spp		3	1 83%
		Sciuridae			unknown	5	3 05%
			Sciurus	griseus	W gray squirrel	6	3 66%
			Tamaisciurs	douglasii	Douglas squirrel	7	4 27%
			Glaucomys	sabrinus	N flying squirrel	1	0 61%
			Tamias	spp	Chipmunks	5	3 05%
			Spermophilus	beecheyii	CA ground squirrel	2	1 22%
	Insectivora	Soricidae	Sorex	spp	Shrews	1	0 61%
		Talpidae	Scapanus	latimanus	Broad footed mole	2	1 22%
					Subtotal	***155***	**94.51%**
Reptilia		Anguidae	Elegaria	spp	Alligator lizard	19	11 59%
		Iguanidae	Sceloporus	spp	Fence lizard	12	7 32%
		Scincidae	Eumeces	spp	Skinks	3	1 83%
					Subtotal	***34***	**20.73%**
Insecta					unknown	22	13 41%
	Colepotera				beetles	8	4 88%
		Buprestidae			jewel beetle	2	1 22%
	Hymenoptera					2	1 22%
		Vespidae	Vespula	vulgaris	Yellow jacket	10	6 10%
					Subtotal	***44***	**26.83%**

VII. ACKNOWLEDGEMENTS

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VIII. PRESENTATIONS GIVEN ASSOCIATED WITH THE KRFP

Thompson, C.M., K.L. Purcell, J.D. Garner, and R.E. Green. Links between landscape condition and survival and reproduction of fishers in the Kings River Experimental Range. Forest Carnivore Working Group in conjunction with the Western Section of the Wildlife Society, 6-9 February 2008, Redding, CA.

Purcell, K.L. "Kings River Fisher Project: Habitat Use and Limiting Factors" Presentation to USFWS Sacramento, 20 March 2008.

Thompson, Craig, and Kathryn Purcell. Status of the Kings River Fisher Project: Two Year Summary. Presentation at 2009 annual conference of the Western Section of the Wildlife Society, 21-23 January, Sacramento, CA.

Thompson, Craig, Kathryn Purcell, and William Zielinski. Using the vegetation composition of fisher home ranges as a template against which to evaluate the landscape effects of proposed fuel reduction projects. Presentation at 2009 annual conference of the Western Section of the Wildlife Society, 21-23 January, Sacramento, CA.

Garner, James, Rebecca Green, Craig, Thompson, and Kathryn Purcell. How much can you learn from scat? The use of scat detector dogs to monitor fisher ecology in the Sierra National Forest. Poster presented at 2009 annual conference of the Western Section of the Wildlife Society, 21-23 January, Sacramento, CA.

Thompson, Craig, Kathryn Purcell, James Garner, and Rebecca Green. The USFS Kings River Fisher Project – 2 year update. Presentation at the Yosemite Fisher Workshop, El Portal, 13 May 2009.

Purcell, Kathryn, Craig Thompson, James Garner, and Rebecca Green. The Kings River Fisher Project: links between fisher population viability and habitat at multiple scales. Poster presented at the 5th International Martes Symposium, 8-12 September 2009, Seattle, WA.

Thompson, Craig, Kathryn Purcell, Rebecca Green, and Rick Sweitzer. The use of radio telemetry in Martes research: techniques and technologies. Presentation at the 5th International Martes Symposium, 8-12 September 2009, Seattle, WA.

Thompson, Craig, Kathryn Purcell, Rebecca Green, and James Garner. Use of scat detector dogs to survey fishers in the Sierra National Forest, California. Poster presented at the 5th International Martes Symposium, 8-12 September 2009, Seattle, WA.

Green, Rebecca, Kathryn Purcell, Craig Thompson, and James Garner. Denning ecology of the fisher in the southern Sierra Nevada. Poster presented at the 5th International Martes Symposium, 8-12 September 2009, Seattle, WA.

Green, Rebecca, Kathryn Purcell, Craig Thompson, and James Garner. Habitat associated with reproductive fisher dens in the southern Sierra Nevada. Presentation at annual meeting of The Wildlife Society, 20-24 September 2009, Monterey, CA.

Thompson, Craig, Kathryn Purcell, Rebecca Green, and James Garner. The use of scat detector dogs to survey fishers in the Sierra National Forest, California. Presentation at annual meeting of The Wildlife Society, 20-24 September 2009, Monterey, CA.

Thompson, Craig, Kathryn Purcell, Rebecca Green, and James Garner. Kings River Fisher Project: 3-year update. Wildlife Society Western Section annual meeting. Visalia, CA. January 2010.

Garner, James, Tessa Smith, Rebecca Green, Craig Thompson, Kathryn Purcell, and Rick Sweitzer. The use of GPS collars to monitor Sierra fishers: preliminary results. Wildlife Society Western Section annual meeting. Visalia, CA. January 2010.

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IX. LITERATURE CITED

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